4   Data Acquisition System

The N3R data acquisition system consists of a modified personal computer (PC) powered by a Intel® Celeron® 600-MHz processor (Fig. 17), two remote (REM) analog-to-digital (A/D) modules, and flash card drive, flat-panel display, and a control switch box for the pilot. The PC and most associated electronics are mounted on the floor of the backseat of N3R.   The data acquisition programs, written in C, run on top of the Microsoft DOS 6.22 operating system.

Fig. 17. N3R data acquisition PC, BAT auxiliary box, Ashtech dual-frequency GPS, and PCMCIA flash disk.

Analog sensor signals are digitized by the REM modules. This electronics package was developed by ARA to provide high-speed, high-resolution, multi-channel data logging. Each REM module consists of two 8-channel A/D boards with 16-bit resolution. The analog input voltage ranges from -5 to +5 volts, translating to a digital resolution of about 0.15 mV. The incoming analog signals are filtered using a 5-pole Butterworth anti-aliasing filter with a low-pass cutoff of 30 Hz. The signals are over-sampled by a factor of 32 before being averaged to 50 Hz for further noise reduction. The digital signals are transmitted to the PC for data storage via RS-422 serial lines. Two REM modules are currently used in the data acquisition system for a total of 32 A/D channels. One is contained in the tapered carbon fiber cone of the BAT probe to the rear of the pressure port dome. The second is inside the BAT auxiliary box located next to the data acquisition PC.

Calibration of the A/D channels for both REM modules was done prior to the CBLAST-Low pilot field study. Precise inputs of -4500, 0, and 4500 mV were inserted into each A/D channel. Simple linear calibration curves were computed for each input channel.

Most of the sensors described in the previous section provide analog signals that are digitized by the REMs. The exceptions include the Ashtech and TANS-vector GPS, and the Riegl lasers. These instruments transmit their respective digital data directly to the PC via RS-232 lines. The GPS data are ingested by the PC at 10 Hz while the Riegl lasers transmit their data at 150 Hz. All of the data are written to the PC hard disk once per second and are copied to a flash card at the end of each flight for post processing.

The Ashtech GPS provides the primary time reference for the data acquisition system. The clock utilized by the Ashtech receiver is synchronized with the time transmitted by the GPS satellites. The clock outputs a one pulse per second signal to the PC. The pulse is also used to synchronize flow of data transmitted to the PC from the REM modules and other digital sensors.

14

Three separate files are created for each flight. These files have the same 8-digit root name which is based on the PC clock when the data acquisition system is started (UTC). The convention is: month (2 digits), day (2 digits), hour (2 digits), and minute (2 digits). Each file has a unique 3-character suffix: ORG, BIN, and MKR.

The ORG file contains binary data from all of the *in situ* and remote sensors which are written in 1-s blocks. This file also contains information (i.e., a "header" listing) regarding device and channel assignments, measurement frequencies, engineering units, ranges, voltage scale factors and offsets, and calibration coefficients.

The BIN file contains binary satellite pseudo-range, carrier phase and Doppler data acquired by the Ashtech GPS during the flight.

The MKR file contains an ASCII listing of specific times and locations during the flight when the pilot toggles the "on", "off", or "event" switch on the control switch box. This file is used to mark the start and end of flux legs, profiles, or other specific maneuvers.

In addition to the three files collected by the N3R data acquisition system, two files are collected from a stationary ground-based Ashtech GPS. These data, when combined with GPS data acquired by N3R, are used to generate differentially corrected positions and velocities for the aircraft. A BIN file contains binary satellite pseudo-range, carrier phase and Doppler data acquired by the Ashtech GPS ground station while N3R was in flight. An EPH file contains the ephemeris information. The location of the ground station was 41° 22' 29.9" N, 70° 31' 38.3" W.